

Consumption of antibiotics in Greenland, 1964–1970

I. Economic and epidemiological considerations

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Recognition of the public health and financial problems involved in the increasing use of pharmaceutical products is of major importance to-day (WHO, 1971). A deeper knowledge of the extent and development of drug consumption is necessary to evaluate the significance of these problems. It is possible to obtain such knowledge in relatively few countries (Engel and Siderius, 1968; NMD, 1972). The various national data assembled for presentation at the WHO Symposium on Drugs in 1969 were not generally comparable, since the mode of registration, the socio-economic factors, and the organization of the local health services varied so widely (WHO, 1970).

One particular aspect of treatment with antibiotics is the coincidental effect on recognized and unrecognized infections, including that on the resistance pattern in hospital infections (Barber, Dutton, Beard, Elmes, and Williams, 1960; Ridley, Lynn, Barrie, and Stead, 1970; Bülow, 1971) and in gonorrhoea (Willcox, 1970; Olsen, 1973a,b). There is also the question of the effect on the incidence of syphilis arising from the action of these drugs on unrecognized treponemal infections (Olsen, 1973c).

An assessment of the consumption of drugs in Greenland proved to be relevant to the investigation of the changes which have taken place in the sensitivity of gonococci to antibiotics (Olsen, 1973b) and to the occurrence in Greenland of cases of syphilis modified by the use of antibiotics (Jørgensen, personal communication; Knudsen, personal communication).

The supply of drugs to Greenland is centralized, and it has thus been possible to obtain detailed information concerning the annual importation of antibiotic preparations.

The aim of the present work was to relate the consumption of drugs in Greenland to the morbidity of bacterial infections and to determine the costs involved. The analysis of the findings was also used to investigate the coincidental effects of drug usage on syphilitic (Olsen, 1973c) and gonococcal infections (Olsen, 1973a, b).

Material

Particulars of the quantities of drugs for oral and parenteral administration supplied to the medical districts in Greenland during the years 1964 to 1970, were obtained from the dispensary of Copenhagen's County Hospital in Gentofte, which is responsible for the dispatch of medicines to Greenland. Information was also given by the dispensary about drugs returned from Greenland.

Results

The total quantities of antibiotics supplied to Greenland are shown in Tables I, II, and III.

Since the hospitals in Greenland are obliged to hold a 6 months' supply of medicine for emergency purposes (Bech, 1963), the storage date may expire before some of the preparations are used. About 1 per cent. of these items are therefore returned to the dispensary in Denmark, and the remainder is destroyed or discarded in Greenland. The full extent of such destruction is unknown, but only such products as procaine penicillin, phenoxymethylpenicillin mixtures, erythromycin mixtures, ampicillin for injection, and streptomycin have a storage limit of 2 years or less, and it is mainly these that are destroyed. If it be assumed that a maximum of 25 per cent. of these less durable drugs are discarded in Greenland and the total supply of these preparations is reduced by the amount destroyed, a useful estimate can be made of the total use of antibiotics in Greenland during the period in question.

Tables I, II, and III (opposite) show the consumption of antibiotics prepared as mixtures, tablets, and injections. Figs 1 and 2 (opposite) show the increase and change in consumption patterns of the chief mixture and tablet preparations. Table I and Fig. 1 show that the use of V-penicillin mixtures increased five-fold between 1964 and 1970, while that of tetracycline, chloramphenicol, and sulphonamide mixtures was more constant. The increasing use of ampicillin mixtures during recent years is possibly counterbalanced by the smaller use of tetracycline

TABLE I *Annual consumption of antibiotic mixtures in Greenland, 1964 to 1970*

Year	1964	1965	1966	1967	1968	1969	1970	Used	Discarded	Supplied
V-penicillin	3.4	5.5	4.3	5.7	7.7	15.1	17.5	59.2	19.7	78.9 1,000 m.u.
Ampicillin	0.0	0.0	0.0	0.1	0.2	0.2	2.7	3.2	÷	3.2 kg.
Tetracycline	2.1	2.1	2.2	1.5	2.3	2.3	1.2	17.7	÷	17.7 kg.
Chloramphenicol	0.6	2.1	1.3	0.6	2.2	0.8	0.8	8.4	÷	8.4 kg.
Sulphonamides	17.4	24.9	27.4	11.9	31.5	14.2	21.9	149.2	÷	149.2 kg.
Erythromycin	—	—	0.0	—	—	—	—	0.0	0.0	0.0 kg.

0.0 = Supplied/Discarded < 0.05 — = None supplied ÷ = None discarded

TABLE II *Annual consumption of antibiotics in tablet form in Greenland, 1964 to 1970*

Year	1964	1965	1966	1967	1968	1969	1970	Used	Discarded	Supplied
V-penicillin	75.1	88.3	92.2	100.5	128.7	158.4	170.3	813.4	÷	813.4 1,000 m.u.
Ampicillin	0.1	0.8	1.0	5.2	4.9	6.1	15.7	33.8	÷	33.8 kg.
Tetracycline	17.8	29.6	42.6	39.7	50.2	65.6	71.4	320.5	÷	320.5 kg.
Chloramphenicol	5.8	2.1	3.3	5.6	3.5	2.1	1.3	23.7	÷	23.7 kg.
Sulphonamides	55.9	56.4	63.3	33.2	45.4	53.2	53.8	361.2	÷	361.2 kg.
Erythromycin	0.3	0.5	0.3	1.4	1.3	0.9	2.1	6.8	÷	6.8 kg.

÷ = None discarded

TABLE III *Annual consumption of antibiotics for parenteral injection in Greenland, 1964 to 1970*

Year	1964	1965	1966	1967	1968	1969	1970	Used	Discarded	Supplied
Benzylpenicillin	105.9	179.4	72.7	75.5	116.3	146.1	140.1	836.1	43.6	879.7 1,000 m.u.
Ampicillin	—	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.3 kg.
Tetracycline	0.5	0.4	0.3	0.3	0.4	0.5	0.6	3.0	÷	3.0 kg.
Chloramphenicol	0.1	—	—	—	—	—	—	0.1	÷	0.1 kg.
Sulphonamide	0.1	0.1	0.2	—	0.2	0.1	0.2	0.9	÷	0.9 kg.
Erythromycin	0.0	0.0	0.0	—	—	—	—	0.1	÷	0.1 kg.
Streptomycin	26.2	8.7	15.9	17.2	17.7	6.7	11.7	104.1	34.7	138.8 kg.

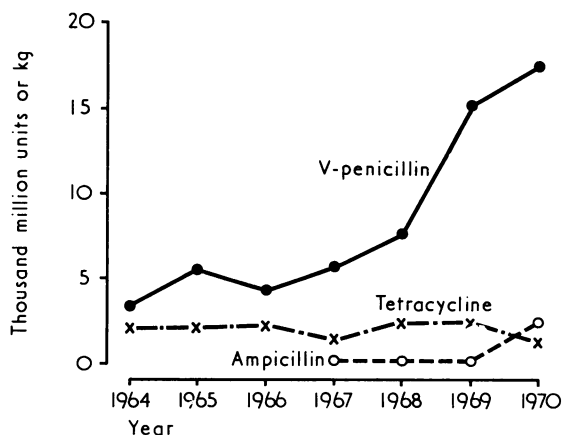
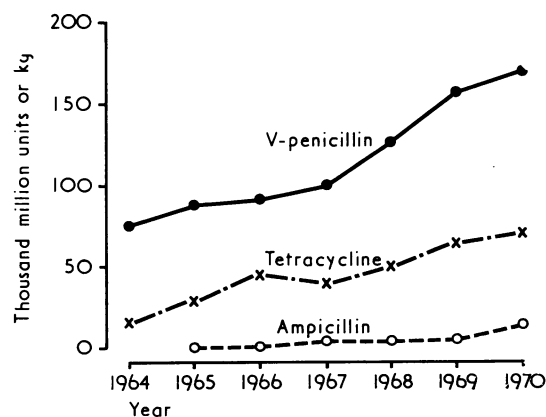
0.0 = Supplied < 0.05 — = None supplied ÷ = None discarded

mixtures and the slower increase in the use of V-penicillin mixtures in 1970.

Table II and Fig. 2 show that the use of V-penicillin tablets more than doubled, while there was a four-fold increase in tetracycline tablets. The use of

erythromycin, and particularly ampicillin, increased, especially during the last half of the period, while that of chloramphenicol decreased.

As with the mixtures, the use of sulphonamides in tablet form was constant. Among the parenteral

FIG. 1 *Annual consumption of main antibiotic mixtures in Greenland 1964 to 1970*FIG. 2 *Annual consumption of main antibiotics in tablet form in Greenland, 1964 to 1970*

drugs (Table III), the benzylpenicillin products dominated; further details are given in Table IV. The use of other preparations for injection, except streptomycin, was limited; streptomycin seemed to be used less as time passed.

Table IV gives details of the consumption of different types of benzylpenicillin. Group I—sodium benzylpenicillin—was used chiefly in the treatment of non-gonorrhoeal infections. There was a slight increase in the total amount, but this was probably due to a change in usage pattern, since larger ampoules containing 2 million i.u. were used more often, and the intensity rather than the frequency of the treatment increased.

Group II—penicillin with lignocaine—was introduced for the treatment of gonorrhoea in South Greenland in 1964 (Lomholt and Berg, 1965, 1966) and came into use all over Greenland from the beginning of 1965 (Olsen and Lomholt, 1969). The figures in the continuous line show the annual usage for the ordinary treatment of gonorrhoea. The figures in parentheses indicate the actual amounts supplied in 1965, 1966, and 1967.

Selected mass treatment of population groups began in Greenland in 1965 (Olsen 1973d). The extent of such treatment was not as great as anticipated, and surplus supplies in 1965 were therefore divided between 1966 and 1967. The figures marked c in 1965 and 1966 show the number of mega units used for selected mass treatment in those years.

In 1964 and the beginning of 1965, procaine penicillin preparations were mainly used for treatment of gonorrhoea in Greenland, which explains their high consumption during those years and the lower figures for 5 m.u. benzylpenicillin with lignocaine in 1964. Apart from the years 1964–1965, the use of procaine penicillin products including PAM was constant, as is seen in the totals in Group III in Table IV.

CONSUMPTION RATE

With the types and doses of drugs used in Greenland, a typical consumption pattern would be expected for the various age groups and for the treatment of gonorrhoea, and also a relationship to marital status. Table V shows the total doses of drugs estimated to have been used for each course of treatment in Greenland. These standard dosages have been used to calculate the total consumption in various population groups.

Table VI shows the calculated annual average number of standard courses of treatment per person in the individual years. In the 0–4 age group, there was a more than three-fold increase in the number of annual treatments between 1964 and 1970, caused particularly by the increased use of V-penicillin mixtures. This increase is undoubtedly correct, since the starting point for the calculations was the use of mixture bottles, irrespective of

TABLE IV *Consumption of benzylpenicillin for parenteral injection in Greenland, 1964 to 1970*

Group	Year	1964	1965	1966	1967	1968	1969	1970	Total (m.u.)		
I	Sodium benzylpenicillin	100,000 u.	44	16	20	—	—	—	80		
		300,000 u.	—	—	—	165	60	—	225		
		500,000 u.	—	—	500	—	25	600	1,125		
		1 m.u.	25,900 ^a	21,700	28,100	14,320	28,100	20,400	154,230		
		2 m.u.	22,000 ^a	15,000	12,600	18,000	27,500	33,800	175,500		
		5 m.u.	—	—	—	—	—	2,500	11,000		
		10 m.u.	4,100	3,000	5,100	2,000	3,300	5,000	4,000		
		26,500									
	Total	52,044 ^a	39,716	46,320	34,485	58,985	62,300	77,310	371,160		
II	Sodium benzylpenicillin with ^b lignocaine	5 m.u.	7,500	(119,525) 24,000 45,000 ^c	(13,000) 37,800 15,000 ^c	(27,250) 37,975	43,475	72,275	51,145	274,170 60,000 ^c	
III	Other benzylpenicillins	300,000 u.	371	360	473	765	—	196	—	2,165	
		600,000 u.	729	1,474	1,507	990	293	338	405	5,736	
		1·5 m.u.	14,063 ^a	1,238	900	112	—	562	—	16,875	
		3 m.u.	31,275 ^a	17,100	10,575	11,925	13,500	10,350	11,250	105,975	
	PAM	300,000 u.	10	17	5	—	7	34	28	101	
		Total	46,448 ^a	20,189	13,460	13,792	13,800	11,480	11,683	130,852	
		Benzylpenicillin total (m.u.)		105,992	83,905 45,000 ^c	97,580 15,000 ^c	86,252	116,260	146,055	140,138	776,182 60,000 ^c

^a = Partly used for treatment of gonorrhoea

^b { Figures in line = penicillin used for ordinary treatment of gonorrhoea

{ Figures in parentheses = actual amount supplied

^c = Penicillin used in mass campaigns

TABLE V *Total dosage for standard courses of treatment used to calculate frequency of antibiotic treatment, by age group*

Antibiotic treatment	Age group (yrs)			
	0-4	5-9	≥ 10	Unmarried ≥ 15
V-penicillin mixture	1 bottle (1.8-3 m.u.)			
Ampicillin	1 bottle (1.5-3 g.)			
Tetracycline	1 bottle (1-1.5 g.)			
Benzylpenicillin for injection		3.5 m.u.	5 m.u.	
V-penicillin tablets		3 m.u.	6 m.u.	
Ampicillin		5 g.	10 g.	
Tetracycline		2 g.	4 g.	
Gonorrhoea treatment (benzylpenicillin)				5 m.u.

TABLE VI *Annual number of courses of treatment with antibiotics acting on both Treponema pallidum and Neisseria gonorrhoeae by age group in Greenland, 1964 to 1970*

Year	1964	1965	1966	1967	1968	1969	1970	Average per year
I. 0 to 4-year-olds								
Penicillin mixture	0.2	0.3	0.3	0.4	0.5	0.6	0.8	0.4
Ampicillin mixture	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Tetracycline mixture	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.2
Number of treatments	0.3	0.5	0.5	0.5	0.7	0.8	1.0	0.6
II. 5 years or older								
Penicillin tablets	0.5	0.6	0.6	0.6	0.8	0.9	0.9	0.7
Ampicillin tablets	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tetracycline tablets	0.2	0.3	0.4	0.4	0.4	0.5	0.5	0.4
Penicillin injection treatment (minus gonorrhoea treatments)	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.5
Number of treatments	1.1	1.3	1.4	1.4	1.7	1.9	2.0	1.6
III. Unmarried ≥ 15 years								
Gonorrhoea treatments	0.7	0.5 1.1 ^a	0.8 0.3 ^a	0.8	0.9	1.2	1.2	1.0
Total number of courses of treatment given to unmarried ≥ 15-year-olds	1.8	1.8 1.1 ^a	2.2 0.3 ^a	2.2	2.6	3.1	3.2	2.6

0.0 = Average number of treatments < 0.05

^a = Selective mass treatments

whether these bottles contained more antibiotic at the end of the period than at the beginning. The calculated consumption for persons aged 5 years and over is shown in Group II. It is especially the courses of treatment with penicillin and tetracycline tablets that seem to have increased (1.8 and 2.5 times more treatments respectively in 1970 than in 1964). However, since some courses of treatment were certainly intensified between 1964 and 1970, the increase in the number of treatments per person was probably not as high as it appears, and the extent to which treatment frequency in this group has changed cannot be stated precisely. However, it would probably be reasonable to estimate that courses of treatment were about 1.5 times more frequent in 1970 than in 1964.

Since the persons treated for gonorrhoea came mainly from the unmarried adult population, the

use of penicillin preparations for gonorrhoea is related to that group. The frequency of treatment was about 1.5 per notified case of gonorrhoea, plus the selected mass treatments in 1965 and 1966. The lower part of Table VI shows the estimated number of treatments per unmarried adult; the frequency, expressed as numbers of standard courses, increased 1.8-fold in the same period.

ECONOMIC CONSIDERATIONS

Since it may be of interest to evaluate the financial aspects of the use of antibiotics, Tables VII to IX and Fig. 3 (overleaf) show the costs in Greenland. These figures enable a comparison to be made with several other published reports (Lázár, 1966; Engel and Siderius, 1968) and personal communications (DAK, 1971, 1972; LS, 1971; NMD, 1972). The

TABLE VII *Total costs in US dollars of antibiotics used in Greenland on the basis of 1970 prices, by type of drug*

Antibiotics		Cost in \$	Per cent. of cost in group	Per cent. of total cost
Mixtures	V-penicillin	36,619	36.1	2.5
	Ampicillin	5,667	5.6	0.4
	Tetracycline	28,041	27.6	1.9
	Chloramphenicol	12,984	12.8	0.9
	Sulphonamide	18,191	17.9	1.2
	Total	101,502		6.9
Tablets	V-penicillin	356,734	45.8	24.5
	Ampicillin	31,675	4.1	2.2
	Tetracycline	353,923	45.5	24.3
	Chloramphenicol	2,708	0.4	0.2
	Sulphonamide	25,766	3.3	1.8
	Erythromycin	7,606	1.0	0.5
	Total	778,412		53.5
Injections	Benzylpenicillin	284,649	49.5	19.6
	Penicillin for gonorrhoea	189,539	33.0	13.0
	Ampicillin	879	0.2	0.1
	Tetracycline	22,898	4.0	1.6
	Chloramphenicol	199	0	0
	Sulphonamide	2,625	0.4	0.2
	Erythromycin	906	0.2	0.1
	Streptomycin	73,316	12.7	5.0
	Total	575,011		39.6
Total cost		1,454,925		

TABLE VIII *Percentage distribution of costs into antibiotic types, per year, and for the whole period 1964 to 1970*

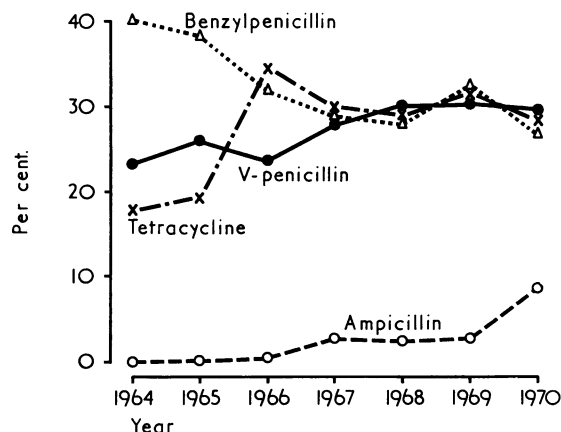
Year	1964	1965	1966	1967	1968	1969	1970	Total
V-penicillin oral	23.4	21.0	26.2	29.2	27.8	30.0	28.9	26.9
Benzylpenicillin parenteral	40.1	50.7	25.1	26.1	30.0	31.5	26.9	32.4
Ampicillin	0.1	0.4	0.6	3.1	2.5	3.1	9.0	3.2
Tetracycline	17.9	19.5	34.5	29.7	28.2	30.4	28.8	27.7
Chloramphenicol	1.2	1.7	1.5	1.0	1.7	0.6	0.5	1.1
Sulphonamide	4.9	3.3	5.1	2.5	3.4	2.2	2.3	3.1
Erythromycin	0.2	0.3	0.2	1.0	0.7	0.4	0.8	0.6
Streptomycin	12.3	3.1	6.8	7.4	5.7	1.8	2.8	5.0

TABLE IX *Costs of antibiotic consumption in Greenland in US dollars per year and per person*

Year	Cost (US\$)	US\$ per person
1964	149,943	4.0
1965	200,518 ^a	5.3 ^a
1966	164,409 ^a	4.1 ^a
1967	163,355	3.9
1968	227,357	5.0
1969	261,427	5.9
1970	288,116	6.2
Total	1,454,925	Mean 4.9

^a = Includes selective mass treatments

calculations are made on the basis of 1970 prices (Medicinfortegnelse, 1970) in US dollars (1 US dollar = approximately 7 Danish kr.). The percentage distribution between mixtures, tablets, and preparations for parenteral use, and the distribution within these groups (Table VII) show that oral treatment involved the highest cost. Despite the

FIG. 3 *Percentage distribution of cost of the most important antibiotic types. Table VIII corrected according to Table IV for 1965 to 1967*

large number of treated cases of gonorrhoea, and the selected mass treatments, their cost comprises only 13 per cent. of the total expenditure. The distribution of costs and the variations for different types of preparation are shown in Table VII, and the most important are presented graphically in Fig. 3. The curves are based on data from Table VIII, but for 1965 to 1967 they are corrected according to Table IV, Group II. The use of benzylpenicillin accounted for 40 per cent. of the total cost in 1964, decreasing to 27 per cent. in 1970, while the cost of ampicillin and tetracycline preparations rose from 18 to 38 per cent. of the total in the same period. The ampicillin preparations comprised 9 per cent. of the total cost in 1970 but accounted for only about 2 per cent. of the treatments given. Table IX shows the costs per year and per person, as well as the total costs (1970 prices). The total cost rose by 92 per cent. from 1964 to 1970, but if the increase in population in the same period is taken into account the cost per person increased by only 55 per cent.

Discussion

The figures for drug consumption in Greenland from 1964 to 1970 show that there was a variable increase in the use of most of the preparations.

As in Denmark, the notifiable infections in Greenland include only those of epidemiological importance. Furthermore, since no morbidity investigation into bacterial infections in Greenland has been carried out, an estimate of the infections requiring treatment and the consequent relevance to drug usage is uncertain.

On account of the socio-economic and hygienic conditions in Greenland (Danmarks Statistik, 1969; Berg, 1973) and the large number of children in proportion to the size of the population, a particularly high frequency of bacterial infections would be expected (Christensen, 1956; Zachau-Christiansen, 1972). This is illustrated by Fig. 4, which shows that the incidence of notifiable bacterial infections (excluding gonorrhoea and syphilis) is almost twice as high in Greenland as in Denmark. It has been demonstrated that the use of medicines is greater when the cost to the patient is smaller (WHO, 1970); drugs are generally supplied cheaply to patients in Denmark and they are completely free in Greenland, so that a comparison between the two areas is justifiable, though account must be taken of the expected greater consumption in Greenland. On the basis of an estimate of the figures from Denmark (DAK, 1971), the use of antibiotic drugs in Greenland still seems to be greater than

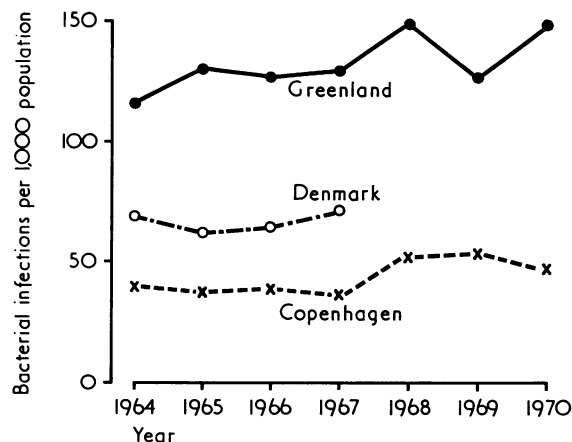


FIG. 4 Number of notified bacterial infections (excluding gonorrhoea and syphilis) per 1,000 population in Greenland, Denmark proper, and Copenhagen

would be expected from the higher frequency of bacterial infections. No details are available concerning the use of antibiotics in Denmark, but it is known (DAK, 1972) that the trend is like that in Greenland, though the increase in Denmark is more moderate. Based on 1970 prices, the cost of drugs rose by 15 per cent. in Denmark and by over 60 per cent. in Greenland from 1965 to 1970. The cost per person in Denmark rose from 2.3 to 2.6 dollars and in Greenland from 5.3 to 6.2 dollars during the same period. The cost of antibiotics in Denmark comprises 15 per cent. of the cost of all medicines requiring a prescription, but in Greenland it forms 36 per cent. of the total cost of medicines supplied from the medical centres.

Though there are national differences in the consumption pattern, it is apparent from the reports available (Lazar, 1966; Engel and Siderius, 1968), and from information received from Scandinavia (LS, 1971; NMD, 1972; DAK, 1972), that there is a general increase in the use of antibiotics in Europe—and probably also all over the world—and that an increasingly large proportion of the preparations used are those for oral administration. The increase has been particularly great for preparations such as tetracycline and, in recent years, ampicillin. According to Halse and Samseth (NMD, 1972), the annual use of antibiotics in Norway is so great that half the Norwegian population could receive treatment for 5 days. This would seem to be about the same as in Denmark and perhaps also in Sweden (Sjøberg, 1967; LS, 1971). The increase is not due to a higher frequency of bacterial infections,

but indicates that drugs are used to treat a greater number of diseases and in larger doses than previously (NMD, 1972; Socialstyrelsen, 1971). This would seem to explain the general increase in the use of pharmaceutical products (Engel and Siderius, 1968). It is reported from Sweden (Socialstyrelsen, 1971) that antibiotics seem to be used too widely, and warning is given especially against the increasing use of ampicillin in cases in which therapy with V-penicillin would have been suitable.

It is hardly justifiable to regard the use of antibiotics in Greenland as much greater than the prevailing conditions require, but since the average use of antibiotics in Greenland is relatively large, the coincidental effects on unrecognized bacterial infections must also be expected to be particularly pronounced.

Summary

Epidemiological, socio-economic, and hygienic factors in a community are of vital importance in determining the need for treatment with antibiotics. Economic resources and the organization of the medical services affect the consumption of drugs. The relatively high incidence of bacterial infections in Greenland, free health service, and free medicines cause more drugs to be used there than in Denmark, where standards of hygiene are higher. The use of antibiotics in Greenland increased by 70 to 80 per cent. between 1964 and 1970 and the expenditure per person in 1970 was 6.2 U.S. dollars. Both the extent of drug consumption and the limited facilities for bacteriological diagnosis make it possible that coincidental effects on unrecognized concomitant disease are frequent.

The use of antibiotics is increasing all over the world, at a rate which varies with local conditions. This is because the drugs are used to treat many more diseases and the total dosage per treatment is markedly increasing. The pattern of antibiotic consumption in Greenland has changed in the same way as in other geographical areas. Oral treatment is used more frequently in preference to parenteral administration. From the bacteriological point of view, the increasing tendency to use the broad-spectrum antibiotics, such as tetracycline and ampicillin, is regrettable.

It is of epidemiological, bacteriological, and economical importance to study the use of drugs

in a community, and to evaluate the extent of coincidental treatment. It is also necessary for assessing whether, from a medical point of view, the expense involved is justified, as against using the money for other public health purposes.

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